Lessons Learned from Large Diameter Sanitary Sewer Pipe Bursting Project:  
Conversion of Abandoned Gravity Sewer Main Into Upsized Sanitary Force Main 
South San Francisco, CA

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ABSTRACT

As an increasing number of large diameter pipe bursting jobs are attempted, more is being 
learned about the capabilities and potential of pneumatic pipe bursting. The large diameter pipe 
bursting project in South San Francisco is one of the most challenging and innovative bursting 
projects ever attempted in North America. It is being heralded as a landmark pipe bursting job.

KEYWORDS

Pipe bursting, Trenchless Technology, Sanitary Sewer, TT Technologies, Carollo Engineers, 
Grundocrack

INTRODUCTION

In 1999, the City of South San Francisco was confronted with a Cease and Desist Order from the 
Regional Water Quality Control Board mandating the elimination of severe wet weather 
overflows within ten years. The City completed a comprehensive evaluation of their wastewater 
collection, conveyance, treatment, and disposal system. Locally deficient sewers, undersized 
pump stations, and hydraulic restrictions in the effluent outfall system were identified as the 
major contributors to the wet weather overflow problem. A five-phase program was developed 
to address these conditions.

Resolving the wet weather overflow problem was such a monumental task that many different 
elements were required. This massive “tool box” of solutions means that every presentation 
attendee should be able to take away valuable insights to benefit his or her own agency.
PROJECT BACKGROUND

Construction of the first phase of improvements has recently been completed. Recognizing the importance of making significant strides early in the program, the first phase was the largest project in the group. Phase 1 Wet Weather Improvements included:

- Replacement of an existing pump station with a new 45-MGD pump station.
- Construction of a new 49-MGD pump station located alongside an existing pump station.
- Construction of 4,100 linear feet of 36-inch diameter force main (1,880 lf installed by pipe bursting from 27-inch to 36-inch); 6,860 linear feet of 42-inch diameter force main (525 lf installed by microtunneling); and 3,340 linear feet of 8-inch to 16-inch gravity sewer replacement (300 lf installed by horizontal directional drilling at Slope=0.0030).
- Expansion of the effluent pump station to the fullest extent possible without constructing a new facility – 60 MGD.
- Construction of a 7.5 million gallon effluent storage pond.
- Addition of 30 MGD influent pumping capacity.

This paper focuses on the design and construction of the force main installed by pipe bursting.

Design and construction challenges included construction sequencing, constrained sites, coordination with other projects, heavy rain and flooding during construction, soft, corrosive, and contaminated soils, high groundwater, congested utility corridors, heavy traffic, freeway crossings, and property issues. Initially, a route was chosen for the new force main to be constructed by traditional open-cut construction. Soils borings performed for the geotechnical investigation, however, identified a high potential for significant differential settlement and a need for extensive shoring that would include, at a minimum, interlocking sheet piles. The geotechnical engineer warned against constructing the force main by open-cut construction methods.

The design team then considered other alternatives for the force main. One part of the project involved constructing a new gravity sewer to replace a 27-inch diameter VCP sewer. An approach that involved utilizing the abandoned sewer as the host pipe for the new force main was developed. This approach would replace the 27-inch sewer with a 36-inch force main, installed using the pipe bursting process.

PNEUMATIC PIPE BURSTING

The Process. Hydraulic and static pipe bursting equipment is common. However, a majority of pipe bursting done in the United States is done with pneumatic tools. During pneumatic pipe bursting, the pipe bursting tool is guided through a fracturable host pipe by a constant tension winch. As the tool travels through the pipe, its percussive action effectively breaks apart the old pipe and displaces the fragments into the surrounding soil. Depending on the specific situation, the tool is equipped with an expander that displaces the host pipe fragments and makes room for the new pipe. As the tool makes its way through the host pipe, it simultaneously pulls in the new pipe, usually HDPE. See Figure 1.
**Figure 1 – Pipe Bursting Process**

**The Tool.** With the use of expanders, one tool can be used to burst several different size host pipes and replace them with new HDPE pipes of the same size or larger. Pipe bursting is the only trenchless method of rehabilitation and replacement that allows for the upsizing of the existing pipe.

**The Expander.** Expander and tool configuration can mean the difference between failure and a successful pipe burst. A very common and effective configuration is a pneumatic bursting tool with a rear expander.

Tool and expander selection is affected by various factors. First, is the host pipe fracturable? Fracturable host pipes include concrete, reinforced concrete, clay, cast iron and transite. PVC and ABS plastic pipe offer some bursting potential. With PVC and ABS, special cutting blades are necessary and the length of runs may be reduced. In part, different expander tool configurations are chosen based on the material, size and usage of the host pipe, as well as its depth and profile. Point repairs made to the host pipe may also affect bursting potential.

Second, consideration must be given to the layout of the work-site. Some jobs require both a launch and exit pit. Other jobs are manhole launched and removed. Still other jobs burst from an launch pit to a manhole. The tool is then reversed out, through the newly installed product pipe. This eliminates the need for an exit pit.
Third is the required burst length. In most sewer replacement applications, the burst length is usually manhole to manhole. Long bursts with large diameter product pipes, may require bigger tools and the addition of polymer or bentonite.

Fourth is the terrain and soil conditions. Most favorable bursting projects involve pipes that were originally installed by trenching or open cut because the fill material surrounding them is usually conducive to pipe bursting. Some soils, like beach sand will not remain in the expanded state long enough for the installation of new product pipe.

Fifth is the product pipe size. HDPE is the most common new pipe material. Due to the weight of larger diameter HDPE, bentonite is used to reduce friction. Tool and expander configurations are influenced by product pipe size.

Upsizing depends on the soil conditions, as well. Extremely large upsizes in the 120-125% range have been successfully completed. These bursts are categorized as experimental and out of the ordinary. The 25-50% upsize is much more common, but is still challenging. Upsizes between zero and 25% are considered common.

**Bentonite Lubrication.** Bentonite lubrication is used in various bursting situations. Due to the weight of larger diameter HDPE, bentonite is used to reduce friction. Friction also increases with the depth of the host pipe. Some soils like beach sand will not remain in the expanded state long enough for the installation of new product pipe. Bentonite lubrication is used in these situations to help maintain the annular space created as the tool travels through the host pipe. Bentonite is pumped through a line that runs inside of the product pipe. A manifold installed behind the tool delivers the mixture to the bursting operation.

**SCOPE OF PROJECT**

The pipe bursting portion of the project called for replacement of 1,800 linear feet of existing 27-inch VCP gravity sewer with new 36-inch O.D. SDR 17 HDPE pipe by the pipe bursting methodology. The existing pipe was approximately 15 feet deep. Via this part of the project, the existing gravity sewer was converted into a sewer force main.

Features of this project include:

- Significant upsize requirement
- Large diameter host pipe
- Geology (Bay Mud) with high groundwater conditions and an aggressive soil
- Traffic Concerns
- Light Industrial area, many small businesses, warehouses, auto body shops, a concrete batch plant, etc.
- Many driveways to deal with
- Significant Truck traffic at all hours
- Host pipe contained a large amount of debris that had to be removed before pipe bursting
- Required Contractor Qualifications for pipe bursting work. It was important to the project designer that a well-qualified and experienced contractor be responsible for the
pipe bursting work. The large upsize and the large diameter of the new pipe make this project an excellent example for others contemplating similar work.

- Good coordination between the General contractor, the pipe bursting sub contractor, the equipment supplier, the engineer, and the City
- Resolution of technical problems on site
- Pipe bursting equipment package, included a 24-inch Taurus Pipe Bursting Tool with a 42-inch Rear Expander, an 18-inch Goliath Ramming Tool to push the column of pipe, a 500 gallon Grundomudd system to provide polymer for lubrication of the new pipe during bursting operations. The use of two 20-Ton Grundowinches, in tandem, to provide adequate constant tension force for this large pipe bursting tool
- Support equipment, large capacity Air Compressors, Water supply for Mud system,
- Onsite involvement of the principals of the contractor D’arcy & Harty
- Onsite technical assistance provided by equipment manufacturer TT Technologies
- Specification changes for static pipe bursting and then a return to pneumatic pipe bursting after static method proved inadequate in the difficult geo-technical conditions
- Involvement of inspection personnel
- Problems with one business owner; he could not be satisfied (had sued the City during other parts of the project)
- Connection of pipe segments after bursting operations. Down Hole fusing of flanges and closure pieces
- Length of installed segments achieved significantly longer than expected (420 lf vs. 350 lf = 20%) and installation rate (200 lf/hr) was excellent
- Surface heave/settlement were well controlled and within acceptable limits

**LESSONS LEARNED**

Such an aggressive program is expensive. However, despite the program’s cost, the City still has one of the lowest sewer user fees in the region.

Quality pipe materials, quality workmanship, and overall successful pipe bursting projects are attainable and are a benefit to all parties. Key specifications issues and customer acceptance criteria should include:

- Clearly determine what issues or project problems exist and need to be addressed. No single pipe bursting technology will fit all situations. In some cases, compatible systems may provide the solution desired.
- The engineer or specifier must consider all variables in designing the pipe bursting project to ensure that the product or process will solve the existing needs without creating other problems.
- Specifications should clearly outline the project performance requirements and final goals.
- Specifications must accurately define project pipe bursting requirements, Contractor qualifications and required equipment submittals for pre-acceptance and approval by the Project Manager/Engineer.
• A Quality Control and Safety Plan that details performance criteria should be a required submittal by the Contractor.
• Quality assurance requirements, testing, inspections and quality control documents during construction, must be specified, outlining the consequences and penalties.
• Incentives, if any, for completing the project ahead of schedule and under budget must be clearly spelled out within the project specifications.
• Contract completion requirements must be included in the project specifications including applicable testing and inspection, installation and product warranties.
• Installation warranty provided by the contractor and product warranty from the pipe manufacturer.
• Include periodic inspections of the complete project in conjunction with warranty periods. The longer the warranty, the more project inspections should be required.
• Repair or replacement requirements for defects discovered during warranty inspections must be adequately defined within the project specifications and reiterated in warranty documentation.
• Extended application warranties will raise contractor risk resulting in higher project costs.
• Well written performance specifications, including QA/QC, testing and inspection requirements during construction will go significantly further in accomplishing quality pipe bursting projects.
• Adequate geotechnical engineering to verify that pipe bursting is the appropriate construction method and to allow contractor to properly select equipment, mobilize forces, and estimate production rates.
• Locate all critical utilities during design so contractor can place pits, identify important crossings, etc.